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Relaxation of Excess Quasiparticles in Superconducting MgB_2

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When a superconductor absorbs a short pulse of light, Cooper pairs are broken leading to an excess quasiparticle population and weakened superconductivity. The weakened state can be sensed as a change in the far-infrared transmission or reflection of the superconducting material. The system returns to equilibrium when the excess quasiparticles have recombined to form pairs and the excess energy has been removed from the system. For a thin film, this process is limited by the escape of phonons into the underlying substrate. We have followed the time-dependent relaxation of photoexcited superconductors by pump-probe far-IR spectroscopy. Figure 1 shows the relaxation for superconducting Nb on sapphire. The decay time is approximately 1 ns; a value that is typical of low-T_c metallic superconductors having a distinct energy gap. Pump-probe measurements on a MgB_2 film (also on sapphire) show relaxation on a very similar time scale (see Fig. 2). This can be contrasted with high-T_c oxide superconductors for which relaxation times are about 100 times faster, probably due to the presence of nodes in the energy gap. The rather long effective relaxation time for MgB_2 suggests this superconducting material has an energy gap without nodes.

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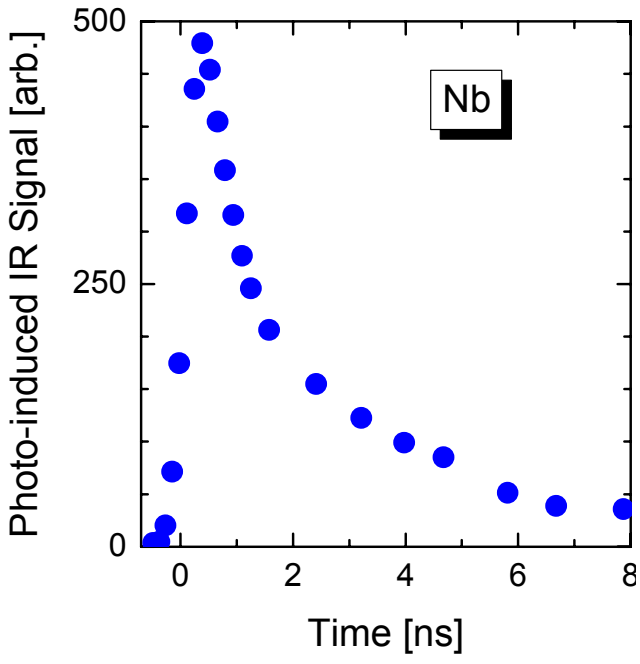

Figure 2. Reflection.

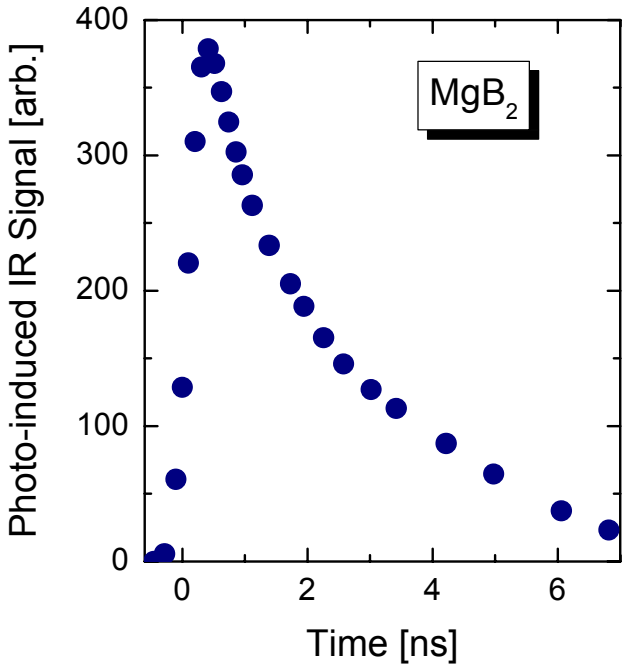

Figure 2. Transmission for various temperatures below T_c, relative to the normal state transmission.